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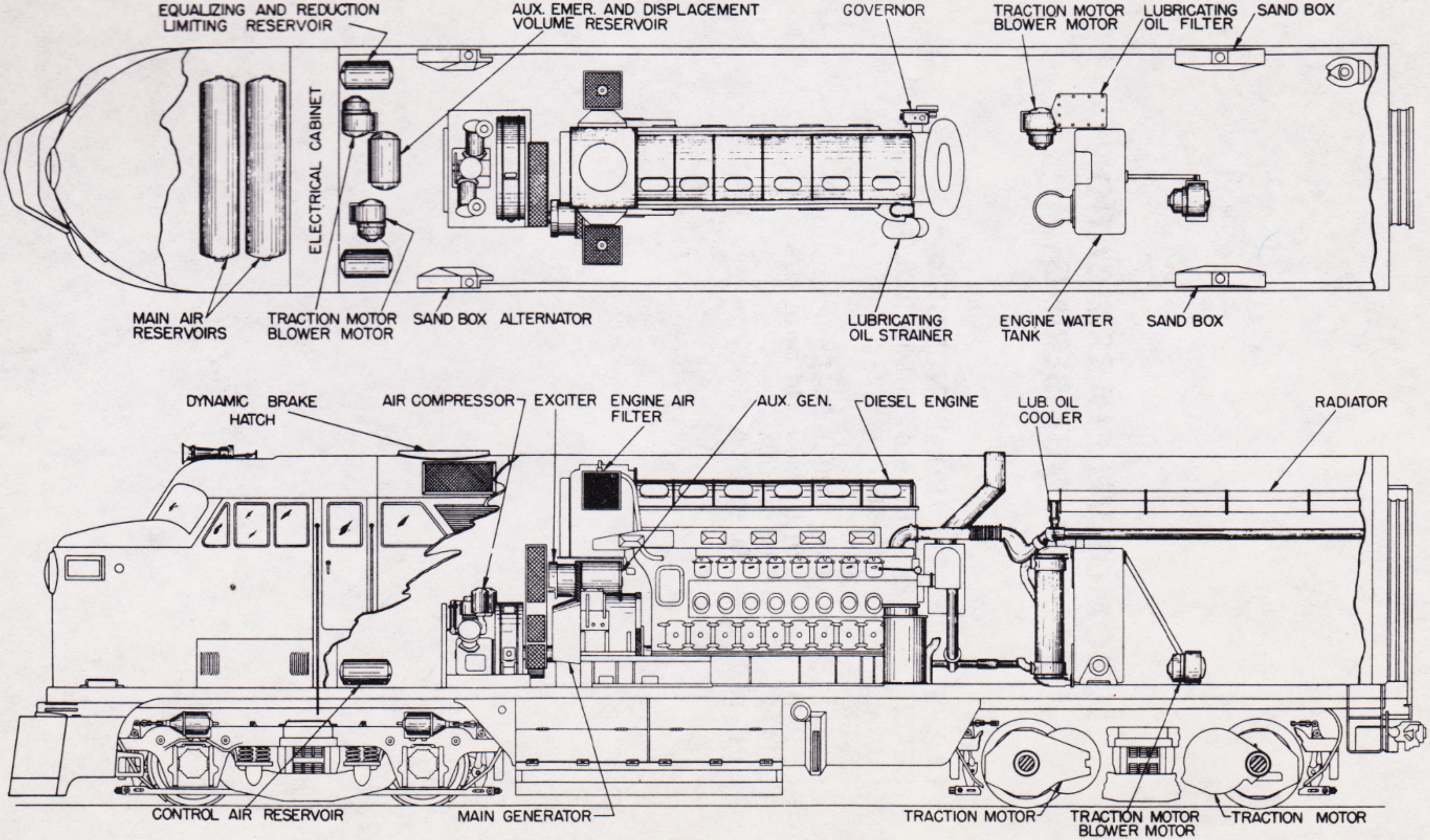
OPERATING MANUAL

DIESEL ELECTRIC LOCOMOTIVES



ARRANGEMENT DIAGRAM CFA-16 **Fig. C-1**

LOCOMOTIVE CLASSIFICATION AND NUMBERING

CLASS	ROAD NUMBERS
CR-12	1600 to 1614; 1618 to 1620; 1622 to 1659
CRG-12	1615-1617
CR-16	2200-2217
CFA-16	9300; 9306 to 9344 even numbers
CFB-16	9301 to 9305 odd numbers
CPA-16	6700 to 6705
CPB-16	6800 to 6805

ROAD LOCOMOTIVES - 1600 HP and UP

The engines are in-line type, two-cycle, 8-1/8" x 10" fully scavenged with an idling speed of 300 RPM and a top speed of 850 RPM. The engine works on the opposed piston principle, two pistons work vertically towards each other in the same cylinder. No valves or cylinder heads are used. The upper and lower pistons drive separate crankshafts which are interconnected by a vertical shaft and gearing. Scavenge air is supplied by a rotary type blower.

Trucks

CFA-16; CFB-16 and CR-16 units use 4-wheel trucks with two motors per truck.

All Passenger units use a 4-wheel leading truck with two motors and a 6-wheel rear truck with two motors, the middle axle being an idler.

Main Generator

The main generator is directly connected to the engine crankshaft through a flexible coupling, and furnishes power to the traction motors. See general section.

Alternator

The alternator is mounted on an extension of the air compressor shaft and furnishes a.c. power to the traction motor blower motors and radiator cooling fan motors.

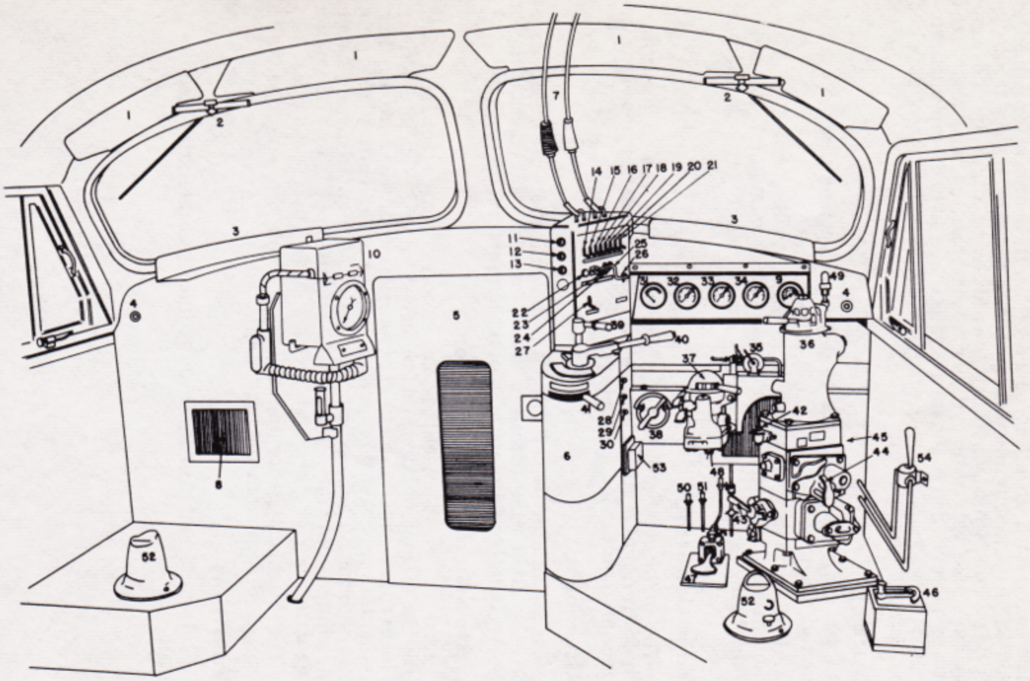
Exciter-Auxiliary Generator

Most of these machines are mounted on a common shaft atop the main generator and are driven by an 8 V-belt assembly. The exciter furnishes main generator excitation and the auxiliary generator provides d.c. power for controls, battery charging, and lighting. The auxiliary generator is regulated for 72 volts at idling, and 75 volts at full engine speed, by the voltage regulator.

The auxiliary generator and exciter on the passenger units are gear driven from the generator shaft.

Transition

Fully automatic on these units during acceleration and deceleration.



1. Sun Visors
2. Windshield Wipers
3. Defroster Openings
4. Windshield Wiper Valve
5. Door to Hood
6. Control Stand
7. Whistle Pull Cord
8. Cab Heater Openings
9. Electric Speedometer (if used)
10. Speed Recorder (if used)
11. Wheel Slip Warning
12. Power Off
13. Brake Warning
14. Headlight Bright
15. Headlight Dim
16. Snow Plow Headlight Bright
17. Snow Plow Headlight Dim
18. Number Light
19. Classification Light
20. Step Light
21. Cab Light
22. Attendant Call Button
23. Fuel Pump Breaker
24. Generator Field Breaker
25. Switch Lock for Engineer's Control Breakers
26. Engineer's Control Breaker
27. Train Order Light
28. Gauge Light Switch
29. Defroster Switch
30. Heater Switch
31. Load Ammeter
32. Main Reservoir and Equalizing Reservoir Gauge
33. Brake Pipe and Brake Cylinder Gauge
34. Application Pipe and Suppression Pipe Gauge
35. Bell Ringer Valve
36. Automatic Brake Valve
37. Independent Brake Valve
38. Rotair Valve
39. Selector Handle
40. Controller Handle
41. Reverser Lever
42. Full Release Selector Cock
43. Brake Valve Cut-out Cock
44. Application Valve Cut-out Cock
45. First Service Cock
46. Dynamic Brake Unit Switch
47. Safety Control Pedal
48. Safety Control Whistle
49. Safety Control Whistle (if Hinged Type Brake Valve Handle used)
50. Cab Signal Whistle
51. Overspeed Whistle
52. Seat Stands
53. Wheel Slip Buzzer
54. Sander Valve

Cab Arrangement Diagram

FIG. C-2.

ROAD FREIGHT LOCOMOTIVES
CFA-16 AND CFB-16 UNITS
OPERATION

LOCOMOTIVE CONTROLS Fig. C-2.

Controller

The throttle. selector and reverser levers on the controller and the automatic and independent air brake valves control all locomotive operation. Breakers and switches must first be in proper position.

Throttle Lever

The positions are: STOP, IDLE, AND 1-2-3-4-5-6-7-8 (running notches.) STOP position shuts down all engines (except an engine which has been isolated) and is obtained by pressing the button on the end of the throttle lever and pushing the lever one notch beyond IDLE. Should only be used in an emergency.

The throttle lever can be moved from IDLE only when the selector lever is in position 1 or beyond and reverser lever inserted.

Selector Lever

Positions are B (braking range) OFF 1-2-3-4 (motoring positions).

Operating Notes:

The selector lever is the top handle on the controller and is used to arrange the circuits for motoring or dynamic brake.

During normal operation the lever should be in position 1. It cannot be moved from 1 to OFF unless the throttle lever is in IDLE.

To move the selector lever into dynamic braking, the throttle must be in IDLE and the reverser lever in FORWARD or REVERSE.

Reverser Lever

Positions are: FORWARD - OFF - REVERSE.

The lever is placed in the position corresponding with the desired direction of locomotive movement.

The lever can be moved only when the throttle lever is in IDLE and the selector lever is in OFF, 1 or 4.

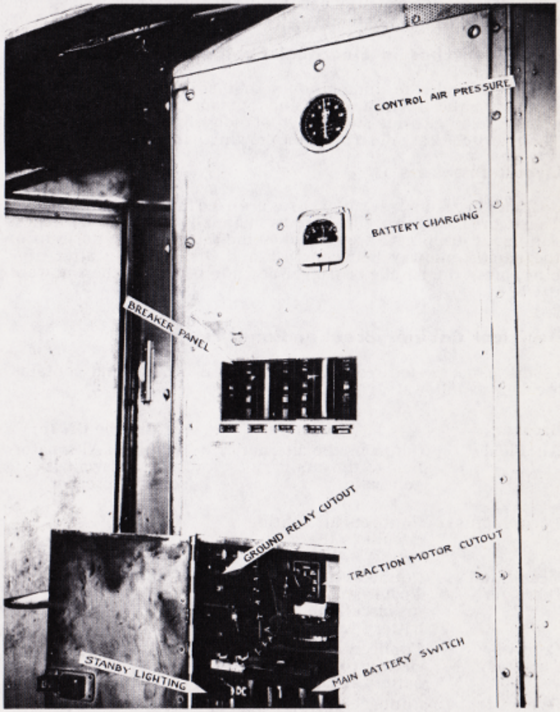
The reverser lever can be installed or removed only when the throttle is in IDLE and the selector lever is in OFF.

Fuses:

Located in the lower left hand corner of the electrical control cabinet, cab side.

1. 150 amp. - only used during shop battery charging.
2. 350 amp. auxiliary generator fuse.

If the latter blows, the ALTERNATOR FAILURE alarm will sound. ALWAYS SHUT ENGINE DOWN BEFORE REPLACING 350 AMP FUSE.



ELECTRICAL CONTROL CABINET
Fig. C-3

Main Battery Switch Fig. C-3.

This is a double pole knife switch located behind a hinged door on the engineer's side of the electrical cabinet. It connects all control and lighting circuits to the battery and must be ON in all units.

Engineer's Control Panel Fig. C-2.

In front of the controller is a panel containing two rows of breakers. The top row includes breakers for lights. The second row includes the CONTROL, FUEL PUMP, and GENERATOR FIELD breakers, and is fitted with a lever for locking the breakers in OFF position in a trailing cab. A signal button labeled ATTENDANT CALL operates the alarm bells in all units. Rheostats are provided for heater, defroster and gauge light control.

Other Switches in Electrical Cabinet Fig. C-3.

Also behind the hinged door and adjacent to the battery switch are the traction motor and dynamic brake cutout switch, ground relay cut-out switch and standby lighting knife switch. These switches are described in following paragraphs.

Circuit Breakers

Circuit breakers instead of fuses are used in all control circuits. These breakers also function as manually-operated switches. Automatic tripping on overload is indicated by the position of the handle midway between OFF and ON. To reset after tripping, press the handle or trigger down to OFF and then upward to ON.

Electrical Cabinet Breaker Panel Fig. C-3.

This panel is located on the electrical cabinet and contains breakers as follows:

Breaker	Function	Must be ON In:
Alt. Field	Connects the alternator field to the auxiliary generator.	**All units.** Alternator failure alarm will sound if breaker trips.
Loco. Lights	Connects all lighting circuits to the main battery switch.	**All units.**
Heater and Defroster	Connects heater, defroster and gauge lighting circuits to the main battery switch.	**Both A units.**
Control Cut-out	Connects all control circuits to the main battery switch.	**All Units.**
Dynamic Brake	Connects the dynamic brake field loop excitation circuit to the main battery switch.	**Lead unit only.**

Dynamic Brake Unit Switch

This switch is located behind the engineer's seat and has four positions for setting according to the number of units in the locomotive consist.

SETTING SHOULD BE CHANGED ONLY AS THE NUMBER OF UNITS ARE CHANGED REGARDLESS OF WHETHER OR NOT A UNIT IS SHUT DOWN EN ROUTE.

Traction Motor and Dynamic Brake Cut-out Switch Fig. C-3.

A four position knob-operated selector switch. NEVER CHANGE SWITCH POSITION UNLESS DIESEL ENGINE IS FIRST ISOLATED. In each TMCO position the generator output is automatically reduced and dynamic brake is inoperative. Switch positions and functions are as follows:

Position	Function
Normal	Normal operation of traction motors and dynamic brake.
TMCO No. 1	No. 1 truck traction motors cut out. Load ammeter will not function.
TMCO No. 2	No. 2 truck traction motors cut out.
Dyn. Br. CO	Dynamic brake cut out on unit without affecting other units. Operation in motoring not affected.

In event of continued ground relay tripping or hot engine alarm, a pair of traction motors can be cut out to reduce generator voltage and keep the engine on the line at reduced power.

Ground Relay Cut-Out Switch Fig. C-3.

This is a breaker-type switch for emergency use and is normally sealed in the ON position.

Standby Lighting Knife Switch Fig. C-3.

This is a double-throw double-pole knife switch. When switch is UP in normal position, the locomotive lights breaker is connected to the locomotive battery. When switch is DOWN, lights are connected for use with shop current.

ALWAYS SNAP OFF LOCOMOTIVE LIGHTS BREAKER BEFORE OPERATING SWITCH, TO AVOID A BAD ARC.

Sanders are electro-pneumatically operated with sanding ahead of each truck in either direction. Control is from the sanding valve on the right of the engineer.

Locomotive Horn

The horn is operated by a valve actuated by the usual pull cord.

A horn shut-off cock is located in the nose on the right bulkhead.

Locomotive Bell

The bell ringer valve, is located between the independent and automatic brake valves.

GAUGES AND METERS

Black Lighting

Engineer's instruments are marked with a fluorescent lacquer which glows under black light illumination, enabling cab to be kept in darkness at night. Light intensity is adjustable through a rheostat located just ahead of the controller. Rheostat positions are: OFF and an adjustable ON range. The heater and defroster breaker on the cabinet breaker panel must be ON for the rheostat to operate.

Load Ammeter and Brake Warning Light

The load ammeter located on the instrument panel indicates current to traction motors on the front truck, either in MOTORING or DYNAMIC braking, with a separate scale for each on the dial.

THE TONNAGE HAULED MUST BE LIMITED TO THAT WHICH WILL ALLOW THE LOAD AMMETER POINTER TO REMAIN IN THE GREEN OR CONTINUOUS ZONE WHEN OPERATING ON THE RULING GRADE.

If the pointer goes into the overload area, except temporarily when starting or accelerating the train, the locomotive is overloaded and TONNAGE MUST BE REDUCED OR HELP OBTAINED.

In dynamic braking, operation within braking speed limits is permissible up to 880 amperes where the RED zone begins, approximately at which point the dynamic brake warning light located on the engineer's control panel will come on. Braking must then be reduced until the warning light goes out. Otherwise traction motors and braking grids will overheat, as braking current capacity is not designed for overload.

Excessive load currents carried for long periods will result in generator and traction motor overheating. Even if faulure does not occur, insulation will be weakened and failure will occur later even with the locomotive running light.

If load ammeter is inoperative (when leading unit is shut down or front truck traction motors cut out), speed at full throttle must remain above 9.9 MPH corresponding to the CONTINUOUS limit on the load ammeter.

Power Off Light

This light indicates tripping of the PC switch, loss of power and dropping of engine speed to IDLE.

The PC switch will trip and the power off light will come on whenever the following air brake applications occur:

Safety Control
Locomotive Overspeed
Emergency

The PC switch is an air pressure switch located at the top of the air brake equipment rack on the right in the nose.

To reset the PC switch and extinguish the power of light,

1. Return throttle to IDLE.
2. LAP automatic brake valve until application pipe pressure builds up to normal.

Wheel Slip Light

The wheel slip light indicates wheel slippage of one or more driving wheels. Power is automatically reduced on unit affected when slipping occurs and the throttle should be reduced and sand applied after slipping stops.

Air Brake Gauges

Air brake gauges are as follows:

Main reservoir and equalizing reservoir, duplex type.
Brake pipe and brake cylinder, duplex type.
Application pipe and suppression pipe, duplex type.

Speed Recorder

The speed recorder is located to the left side of the engineer and includes a speedometer dial and recording tape.

Control Air Gauge *Fig. C-3*

This gauge is located on the electrical cabinet and indicates pressure of control air to operate the power contactors, reverser, and cam switch. Normal reading is 90 psi. A shut-off valve in the control air line is located in the left of the electrical cabinet on the engine room side.

Battery Ammeter *Fig. C-3*

This meter is located on the electrical cabinet and indicates the charge or discharge rate. With engine running, this meter should always indicate a charge. After the engine has been in operation for a period of time, the reading should show only a small charge. A continuously high charge reading should be reported for attention.

OTHER CAB EQUIPMENT

Cab Heaters

There are two hot water cab heaters, one on either side of cab with motor driven fans, under control of the cab heater switches, providing air circulation. Water to the heaters may be shut off by a valve located on the left side of the engines. On passenger units a small valve admits steam to the hot water lines, and is located overhead in the nose. The heaters are piped in parallel.

Special precautions:

1. Always keep shut-off valve open in cold weather, except when unit is shut down and heaters are drained.
2. Never admit steam to heaters unless the engine is down, and then not without the water valve open. The heater elements are not designed to stand the temperatures of live steam.

Emergency Fuel Trip

There are three emergency fuel trips on the locomotive, each connected to close the one emergency fuel out-off valve at the left rear corner of the fuel tank when the ring is pulled. One trip is located in the operating cab behind the left side seat, and one on each side of the locomotive at the fuel tank. The cut-off valve shuts off fuel to the steam generator (if so equip-

ped) as well as the engine, and when pulled must be reset by hand. On CFA-16 units and CP-16 units another pull ring is located in the engineroom at the engine control panel.

ENGINE ROOM CONTROLS AND GAUGES

Engine Control Panel and Gauges *Fig. C-4*

The engine control panel and gauges are located on the right side wall opposite the governor end of the engine. Included are:

1. Fuel pump breaker
2. Isolation switch
3. Engine stop button
4. Alarm lights:
   Surge relay - WHITE
   Ground relay - WHITE
   Low lube oil pressure - YELLOW
   Alternator failure - BLUE
   Hot engine - RED
5. Ground relay and surge relay remote reset buttons
6. Fuel oil pressure gauge

The lube oil pressure and fuel oil pressure gauges on later units are mounted on the engine water tank.

The engine water temperature gauge is located on the engine water outlet header.

Fuel Pump Breaker *Fig. C-4*

This breaker on the engine control panel starts the fuel pump but not unless the engineer's fuel pump breaker is first closed. The breaker is of the double-pole type and also energizes the auxiliary generator field and exciter battery (4-pole) field. If this breaker trips, engine will starve for fuel and alternator failure alarm light will come on.

Engine Stop Button *Fig. C-4*

This button on the engine control panel will stop the engine after it is isolated. Control cut-out breaker on electrical cabinet must be ON for this button to operate.

Isolation Switch *Fig. C-4*

This is a lever type switch having three positions:

START - Handle upward, pulled to right, and upward against spring pressure.

IDLE - Handle horizontal.
Engine is ISOLATED or OFF THE LINE and will remain at idling speed regardless of throttle position. Other units are not affected.

In this position the alternator failure alarm will not operate.

An isolated engine cannot be shut down by placing throttle in IDLE.

The engine stop pushbutton on the engine control panel is operative only with the isolation switch in IDLE position. The emergency engine stop button on the engine is always operative.

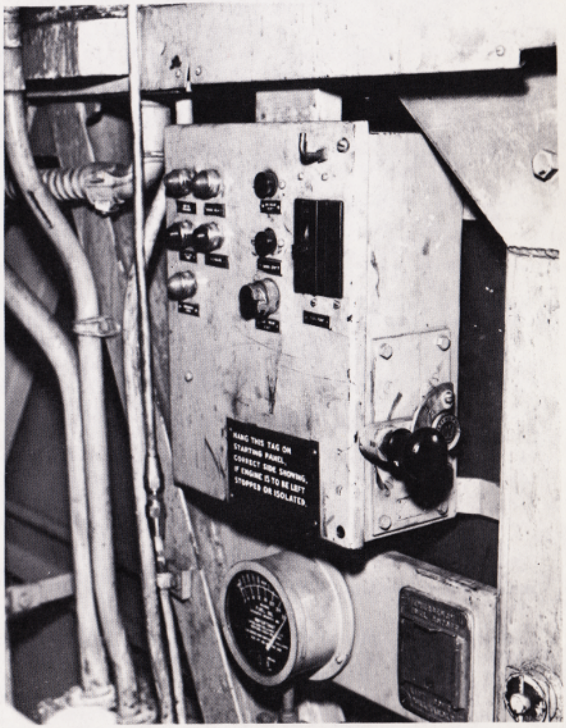
RUN - Handle downward.
This places the engine under the engineer's controls, or ON THE LINE.

Emergency Engine Stop Button *Fig. C-5*

This is a large RED pushbutton located on the engine above the governor. Its function is to stop the engine in an emergency.

Engine Overspeed Control

The function of the overspeed governor is to stop the engine should the governor fail to hold the engine below its maximum permissible speed. To reset pull the overspeed reset lever to the left and release. Fig. C-5



ENGINE CONTROL PANEL
Fig. C-4

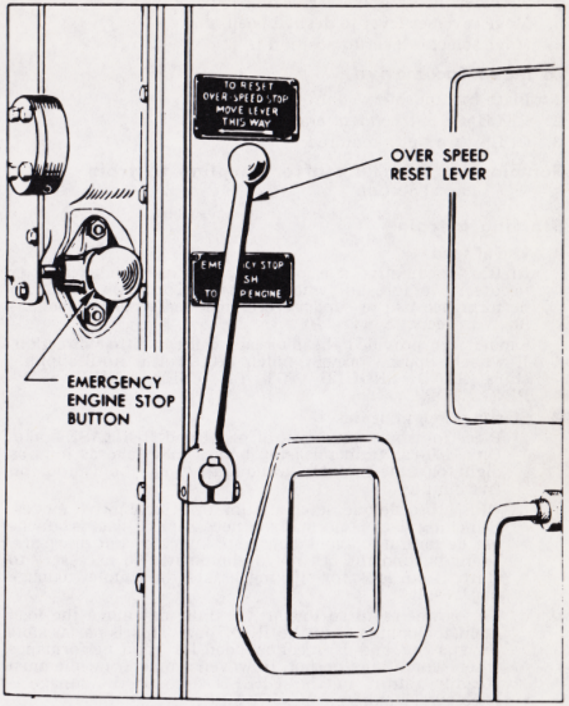
OPERATION

Equipment on each unit should be positioned as follows:

	TRAILING A - UNIT	B - UNIT	LEADING UNIT
Main Battery Switch	ON	ON	ON
Throttle Lever	IDLE	IDLE	IDLE
Selector Lever	OFF	-	1.
Reverser Lever	REMOVED	OFF	OFF
Rotair Valve	PASS. LAP OR FREIGHT LAP	-	PASS OR FREIGHT
Controlled Emergency Cock, D-24		SET SAME AS LEADING A - UNIT	
Control Valve	-	ROTAIR	-
Automatic Brake Valve	CUT OUT	-	CUT IN
Engineer's Switch Panel Breakers			
Control	OFF	OFF	ON
Fuel Pump	OFF	OFF	ON
Generator Field	OFF	OFF	ON
Electrical Cabinet Breaker Panel Breakers			
Alternator Field	ON	ON	ON
Locomotive Lights	ON	ON	ON
Heater and Defroster	ON	-	ON
Control Cut-out	ON	ON	ON
Dynamic Brake	OFF	-	ON
Train Control Breaker (if used)	OFF	-	ON
Control Air Pressure, psi	90	90	90
Battery Ammeter	CHARGE	CHARGE	CHARGE
Traction Motor Cut-out Switch	AS DESIRED	AS DESIRED	AS DESIRED
Ground Relay Cut-out Switch	SEALED ON	SEALED ON	SEALED ON
Dynamic Brake Unit Switch	SET FOR NO. OF UNITS IN LOCOMOTIVE	-	SET FOR NO. OF UNITS IN LOCOMOTIVE.

To Start Engine and Put on Line

1. Snap ON fuel pump breaker at engineer's breaker panel.
2. Check engine overspeed trip and governor low oil shutdown button.
3. Snap ON fuel pump breaker at engine control panel and note that fuel oil pressure builds up to 20 psi.
4. Pull isolation switch knob out and upward against spring pressure to START position. Hold until engine fires and lube oil pressure reaches 7-9 psi. The engine should start turning



OVERSPEED RESET LEVER
Fig. C-5

promptly and firing should occur within a few revolutions. If engine fails to fire, release isolation switch and repeat. If failure again occurs, investigate for cause as continued unsuccessful attempts will run down the batteries.

5. To put engine on the line, turn isolation switch to RUN position. NOTE: ENGINE WILL NOT DELIVER POWER IF STARTING CONTACTORS STICK CLOSED.

   DO NOT PUT AN ENGINE ON THE LINE OR TAKE OFF LINE WHILE DYNAMIC BRAKE IS APPLIED.

Before moving locomotive

1. Check that main reservoir pressure is being maintained at 115-125 psi.

2. Set independent brake. RELEASE hand brake.
3. Move reverser lever to desired position.
4. Move selector lever to position 1.

To Move Locomotive

1. Place foot on safety control pedal.
2. RELEASE independent brake.
3. OPEN throttle as required.

Pumping up train line after coupling to train

-See General Section

Starting a train

1. **Use of sand**

   On this locomotive it is permissible to use sand whenever necessary to forestall wheel slippage. To obtain maximum performance use of sand is recommended where slippage is likely to occur.

   Sanders are provided ahead of each truck in either direction. If wheel slipping occurs, notch off throttle until slipping stops. SAND SHOULD NOT BE USED UNTIL SLIPPING STOPS.

2. **Starting Freight Trains**

   a) Place foot on safety control pedal and RELEASE brake. On a 100-car train releasing brakes may take as long as eight or nine minutes, although normally only four on five minutes.

   b) OPEN throttle one notch at a time until locomotive moves. Bunching slack is normally unnecessary. If slack is bunched, be careful to avoid damage to knuckles and drawbars. Going beyond the 5th notch should not be necessary to start. If so, look for sticking brakes, or coupler damage may result.

   c) The power required to start the train may move the load ammeter pointer into the RED zone. This is permissible on starting and is recommended for good performance where conditions permit. However, ammeter needle must steadily return to the GREEN zone or the tonage is excessive. Maximum speed 70 MPH.

Braking with Power

If power is left on to keep slack out when applying brakes for slow down, use reduced throttle and keep independent brake FULLY RELEASED while applying train brakes. Throttle must be in IDLE when locomotive stops. Continued application of power to traction motors when locomotive is stationary, even for a short period of time, will result in serious damage to the traction motors.

Reversing

Bring locomotive to a dead stop before moving reverser handle for opposite locomotive movement. Applying power in reverse direction, before locomotive stops, may cause serious damage to traction motors.

Passing Over Railroad Crossing

-See General Section

Operating Through Water

-See General Section

Changing Cabs

Before leaving cab:

1. Move selector lever to OFF and throttle to IDLE. REMOVE REVERSER HANDLE.
2. Make 30 psi brake pipe reduction, close brake pipe cutout cock, move rotair valve to LAP, and remove brake handle.
3. Open control, generator field, and fuel pump breakers at engineer's breaker panel. Open dynamic brake braker on electrical cabinet. Engines will run long enough for a man to reach the other cab.

New leading cab:

1. Close fuel pump, control and generator field breakers at engineer's breaker panel. Close dynamic brake braker, on electrical cabinet.
2. Check for correct position of dynamic brake unit switch behind engineer's seat.
3. Insert brake handle, move rotair valve to PASS or FRT as required make full independent brake application and OPEN brake pipe cutout cock.
4. Insert reverser lever and make air brake tests.

Operating with Leading Unit Shut Down

Open control and fuel pump breakers at lead unit engineer's breaker panel and close these breakers on trailing unit. Avoid having both ends on at same time as battery equalizing currents may be enough to damage control wiring.

Dynamic Braking

Operation of Controls

1. Check that the dynamic brake unit switch behind the engineer's seat is set for the number of units in the locomotive.
2. Check that the dynamic brake circuit breaker on the panel behind engineer is closed.
3. Upon entering dynamic braking, always wait a few seconds in each control step before proceeding. This protects against excessive current surges and motor flashovers.

   The dynamic brake retards the train similarly to a strong independent brake, so the same care must be used in controlling slack.
4. Place throttle in IDLE. Wait at least ten seconds, to allow plenty of time for the power contactors to open, and the engine speed to come down to IDLE:
5. Move selector lever to OFF. This will throw the cam switch from MOTORING to BRAKING position.
6. The load ammeter will indicate a reading, which is a measure of the braking effort being produced.
7. After a few seconds, move selector until it latches in the FIRST braking position. Here the engine speed is increased automatically to second notch speed.

8. After slack is bunched, move the selector lever to the right to give the desired amount of braking. Do not allow the ammeter pointer to go into the RED area of the braking band on the scale.
9. The brake warning light is set to come on when the pointer enters the RED area. Slight differences in characteristics between units may cause the warning light to come on while the pointer is still in the WHITE zone. The light governs and braking must always be reduced until the light goes out.
10. DO NOT MOVE THE SELECTOR LEVER BEYOND FIRST BRAKING POSITION AT 50 MPH OR OVER.
11. The automatic air may be used at any time along with the dynamic brake. An interlock on the D-24 control valve of each unit keeps the automatic brake from applying on the unit when the dynamic brake is in use. The independent brake is always available. KEEP INDEPENDENT RELEASED IN DYNAMIC BRAKING.

    Note that if a unit is isolated, so that its dynamic brake is inoperative, air brakes on the unit will still not apply while the rest of the locomotive is in dynamic braking. This is because the dynamic brake interlock remains energized on a unit, even if it is isolated, as long as the engineer is operating in dynamic braking.
12. A brake-valve initiated emergency air brake application will automatically nullify the dynamic brake and allow locomotive brakes to apply. The selector must be returned to the OFF position to restore the dynamic brake.
13. As the speed decreases, braking effort builds up to a maximum near the locomotive continuous speed and then decreases at a sharp rate. However, there is still considerable braking left at 8 MPH and often this is more effective than the independent brake.

    The brake must not be expected to stop heavy trains in short distances or to slow trains down on heavy grades.
14. At low speeds, dynamic braking effort decreases sharply. Around 5 MPH the dynamic brake may be released by moving the selector lever to No. 1 position and applying the independent brake to keep slack from running out.

Manipulating Dynamic Brake on Level Track

When maximum braking slows the train, the ammeter pointer will fall back as train speed drops. To maintain maximum braking, move the selector lever to the right to keep the pointer at the upper end of the WHITE zone. If a steady speed is desired rather than a slowdown, ease off by moving the lever to the left until the required speed is reached. To hold this speed, move the lever forward to retard or back to accelerate.

The dynamic brake is not intended for use in bringing a train to a stop. Braking force diminishes rapidly as speed drops below continuous. However, if the distance available for the stop is sufficient and it is desired to avoid an automatic air application for some particular reason, the train may be slowed down gradually with the dynamic brake.

Manipulating Dynamic Brake on Grades

On heavier grades the dynamic brake may be insufficient to hold the train. The train speed will increase causing the ammeter

pointer to move into the RED area. Keep moving the handle back to hold the pointer in the WHITE area. When the train speed nears the maximum authorized, make an automatic air brake application to check the train. Do not change the position of the selector lever. After reducing speed, release the air and allow the dynamic brake to hold the train while the brake pipe is being recharged. When the air brakes apply, the ammeter pointer will drop back. After release of the air, the train will again gain speed, assuming the grade conditions are the same. This will bring the ammeter pointer up again. When the pointer nears the limit of the WHITE zone, the speed will again near the current limit and another air brake application should be made.

This method of train handling will maintain a nearly constant speed if light air applications are made which will reduce the speed very slightly. Actually, the effect of a light air application will first show as a movement of the ammeter pointer before it is noticeable on the speedometer as a drop in speed. Thus, if the air is released as soon as the ammeter begins to fall back, the speedometer will remain practically steady. After some practices in judging the frequency and amount of air applications, an engineer will be able to descend a grade at a constant maximum speed which will materially lower the running time.

A similar procedure should be used when the grade includes stretches where the speed is restricted because of curves, yards, track conditions etc. By the use of heavier air applications, the speed can be reduced to meet the restriction. After passing a restricted area, release the air and allow the train to come up to the normal speed for the grade where the pointer will again reach the top of the WHITE area. This method will accomplish smooth train handling.

Severe conditions of grade and tonnage may make continuous full use of dynamic braking desirable. Advance the selector lever during air applications to keep the pointer at the limit of the WHITE zone. After air release, ease off the selector lever to keep the ammeter pointer out of the RED area. This handling requires more manipulation by the engineer and is seldom necessary.

Locomotive Overspeed

Exceeding maximum permissible locomotive speed of 70 MPH will cause a full service brake application, tripping of the PC switch, and the POWER OFF light to come on.

A 4 seconds time delay is provided during which a warning whistle sounds, and an unwanted brake application may be forestalled by reducing speed within 4 seconds, or making FULL SERVICE application.

Safety Control

- See General Section

Brake Cylinder Cut-Out Cocks

The brakes on any truck can be cut out by closing the brake cylinder cut-out cock located under the car body above each truck on the right side of the unit.

Fuel Pressure

The fuel pressure should be approximately 25 lbs. at IDLE and 16 lbs. at FULL engine speed.

LUBRICATING OIL SYSTEM

General

The lubricating oil system serves a dual purpose by furnishing oil to the engine for cooling the pistons and lubricating the various bearings and wearing parts under pump pressure.

Flow of Lube Oil

The engine driven lubricating oil pump draws oil from the engine crankcase through a coarse strainer, and pumps it through the 6-element filter to the oil cooler. Here, the oil is circulated around water cooled tubes and then piped through a fine strainer to the engine oil headers. Flow continues through the engine parts and back to the crankcase.

Low Oil Pressure Protection Fig. C-6.

The governor has a built-in engine low oil pressure shut down protection.

Engine Low Lubricating Oil Shutdown

If engine lube oil pressure falls below a preset amount for each engine speed the governor will stop the engine. The alarm bells will sound in each unit of the locomotive and the YELLOW low oil and BLUE alternator failure alarm lights will show on the engine control panel of the unit affected.

A pushbutton on the engine side of the governor housing will move out approximately 3/8'' exposing a RED band around the button. To stop the alarm:

1. Push in button on governor. This will put out YELLOW low oil alarm light.
2. Isolate engine. This will stop alarm bells and put out BLUE alternator failure alarm light.

The governor pushbutton will trip only from an actual low oil alarm and not if the engine stops for any other reason.

A time delay is provided so that after a low oil alarm the engine may be started and idled for approximately forty seconds so that the cause of low oil pressure may be determined. Attempting to put the engine on the line during the 40 second period will cause an immediate shutdown if the low oil pressure condition, which caused the engine to stop, is still present.

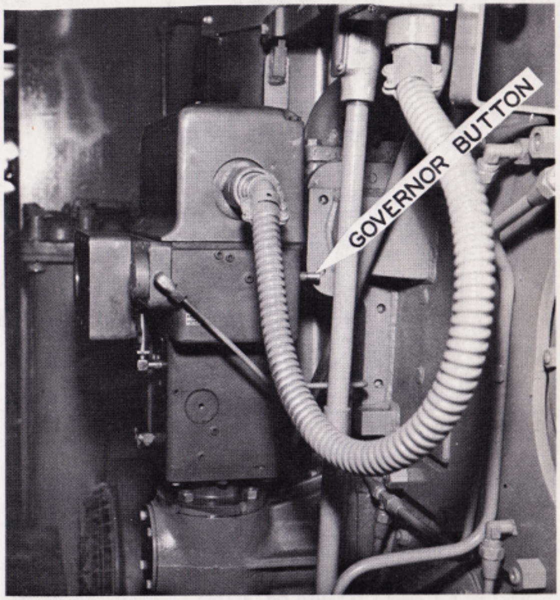
COOLING SYSTEM

General Description

A single cooling water system is utilized with one engine-driven centrifugal pump circulating water through the engine, radiators, and lubricating oil cooler.

Water is drawn from the engine water tank by the engine-driven pump, circulating water through the engine cooling passages to two parallel banks of radiators in the cooling hatch. After being cooled, the water passes through the lubricating oil cooler to the engine.

Air for cooling the radiators enters through shutters on the sides of the locomotive unit. The air is drawn through the radiators and expelled through openings in the roof by three alternating current motor driven fans mounted at the top of the cooling hatch.

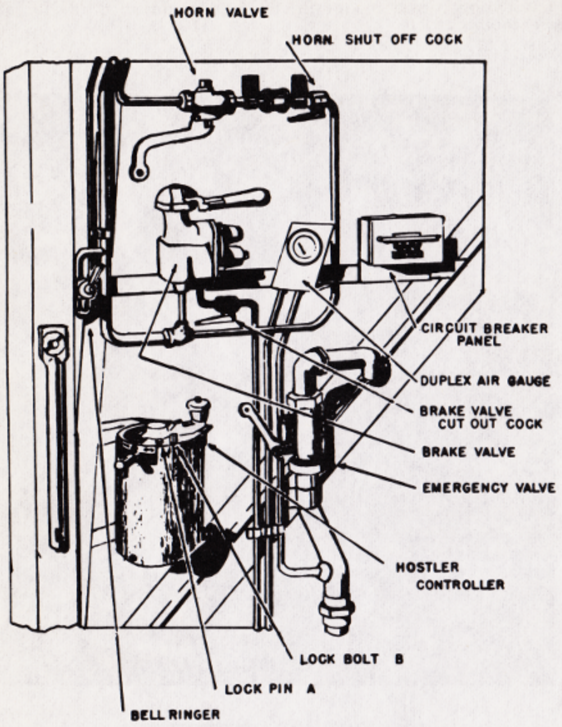


LOW LUBE OIL PROTECTION
Fig. C-6

OPERATING THE "B" UNIT

The B unit is similar to the A except that it does not have an operating cab, but can be moved independently by the hostler's controls. Operation at the hostler's station requires the following breakers on the circuit breaker panel be ON - fuel pump - generator field and control. The brake valve cut-out cock must be CUT IN. Movement of the reverser lever and throttle lever places the unit under automatic transition control, this applies to all units properly connected to it.

Following is a description of the various control devices included in the B unit.



B UNIT HOSTLER CONTROLS
Fig. C-7

Hostler Controller Fig. C-7.

The throttle has these positions: IDLE and eight running notches.

The reverse lever has three positions: FORWARD, OFF, and REVERSE.

Brake Valve

The Straight Air Brake Valve is mounted above the hostler controller. The handle is removable in the full ON position. A cut-out cock is provided in the air line from the brake valve to the application and release pipe.

Circuit Breaker Panel

A panel with three circuit breakers is mounted to the right of the brake valve. These are control, fuel pump and generator field. A locking lever is provided to lock the breakers in the OFF position.

Horn Valve

A horn valve and cut-out cock is located directly above the brake valve. The horn is mounted atop the forward square end hatch.

Bell Ringer Valve

The bell ringer valve is located just to the left of the brake valve.

Air Gauge

A Duplex Air gauge is provided to indicate brake pipe and brake cylinder pressure.

Emergency Brake Valve

An emergency vent valve is mounted near the hostler controller to quickly vent brake pipe air in case of emergency.

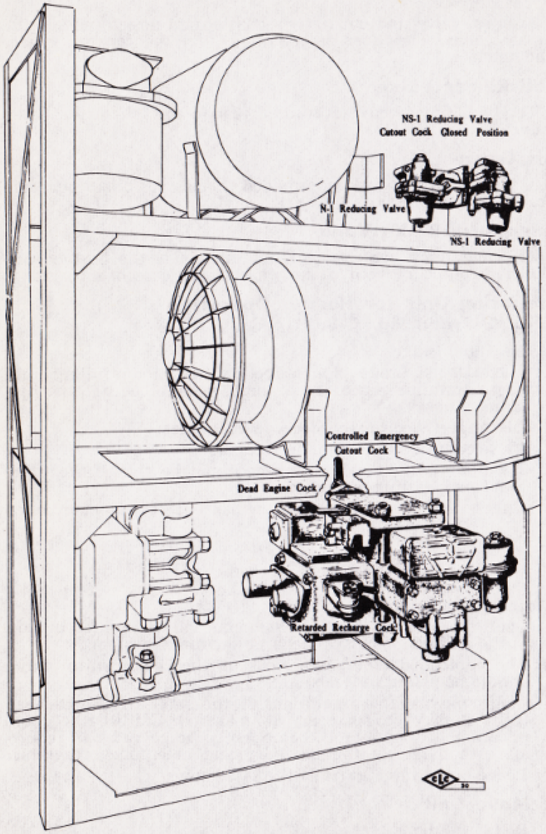
Preparing Unit for Hostler Operation Fig. C-7 and Fig. C-8.

1. Set Hand Brake.
2. Make 30 psi brake pipe reduction in the controlling unit. Close trainline air cocks at both ends of B unit and disconnect hoses.
3. Disconnect electrical jumpers in vestibules.
4. Close control and fuel pump breakers.
5. If engine is not already running it may be started according to normal starting procedure.
6. Check that main reservoir pressure is being maintained at 115-125 psi.
7. Insert brake valve handle.
8. Open the cut-out cock in the brake valve line. Move brake valve handle into the APPLICATION zone.
9. Open the cock at the NS-1 Reducing Valve mounted on top of the air brake panel to recharge the brake system.
10. The controlled emergency cock on the D-24, control valve should be placed in P position.
11. Check brake valve operation. If the brakes fail to release fully, it may be necessary to make an EMERGENCY application by opening the emergency brake valve to reduce an overcharge of the auxiliary and emergency reservoir.
12. Leave brake valve in APPLICATION zone.

To Move Unit

1. RELEASE hand brake.
2. Check that isolation switch (engine control switch on later units) is in RUN.
3. Close generator field breaker.
4. Move reverser lever to required direction of travel.

5. RELEASE air brakes and notch out throttle as desired.
6. If it is necessary to reverse the direction of the unit move throttle to IDLE and bring unit to full stop before moving the reverser lever.



AIR BRAKE STAND - "B" UNIT
Fig. C-8

To Stop a B Unit

1. Move throttle to IDLE and apply independent brake.
2. Switch generator field and control breakers OFF.
3. Turn the isolation switch or EC Switch to IDLE.
4. Apply hand brake.

To Shut the Engine Down

1. Turn the isolation switch or engine control switch knob to STOP.
2. Open fuel pump breakers on engine control panel and hostler breaker panel.

To Couple a B Unit to a Standing A Unit

1. Use the hostler controls to back the B unit up to the A unit.
2. When the couplers lock, make full brake application.
3. Close the brake valve cut-out cock and remove and store brake handle.
4. Close the NS-1 reducing valve cut-out cock on the brake stand.
5. Apply the hand brake.
6. Turn the isolation switch, (EC Switch) to IDLE and open the control and generator field brakers on the hostler breaker panel.
7. Open the fuel pump breaker on the hostler breaker panel. This will stop the fuel pump but the engine will keep running until the fuel in the fuel headers is used up, long enough time to take control from lead unit.
8. Connect up the electrical jumper cables between the units.
9. Connect air hoses between units and open brake pipe cut-out cocks.

GENERAL INFORMATION

Double-Heading an A Unit Behind Another Locomotive

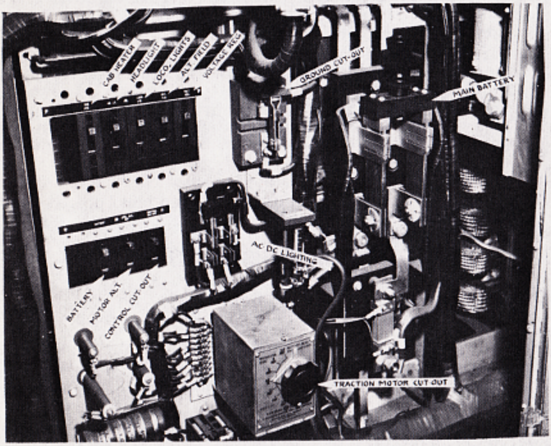
1. Make a FULL SERVICE AUTOMATIC brake application.
2. Close the brake pipe cut-out cock.
3. Leave the rotair valve in FRGT or PASS depending on type of service.
4. Release locomotive brakes by depressing the independent brake handle.
5. Only the emergency feature is retained.
6. Throttle must be in IDLE before train comes to stop and during a stop.

Dead-heading an A Unit

1. Close the brake pipe cut-out cock and remove the brake valve handle in the RUNNING position.
2. Remove the independent brake valve handle in the RELEASE position.
3. Place the rotair valve in PASS.
4. If the engine is shut down, open the dead engine cock on the D-24 control valve.

Dead-heading a B Unit

1. If the engine is not running, open the dead engine cock on the D-24 control valve.
2. Secure the hostler's brake valve in the OFF position and open the brake cut-out cock located below the throttle.
3. Place the controlled emergency and retarded recharge cocks on the D-24 control valve in the PASS position.
4. Close the NS-1 reducing valve cut-out cock on top of the air brake stand. This is closed in the horizontal position.
5. The B unit must have an atmospheric opening from the actuating pipe (A) and the independent application and release pipe (AR), to insure a release of the automatic brake. Open the cut-out cocks on these brake pipes at one end of the unit.



PORTION OF HIGH VOLTAGE CABINET
Fig. C-9

PASSENGER LOCOMOTIVES
CPA-16 AND CPB-16 UNITS

OPERATION

To Start the Engine

1. Close the main battery switch in the front of the high voltage cabinet. Fig. C-9
2. Close the following circuit breakers located on the breaker panel in the front of the high voltage cabinet. Fig. C-9.
   a) Battery
   b) Control cut-out
   c) Locomotive lights
   d) Alternator field
   e) Voltage regulator
3. Close the following circuit breakers on the engineer's control panel. Fig. C-10.
   a) Control
   b) Fuel pump
4. Press engine run button on the engineer's control panel.
5. Place throttle in IDLE; the reverser in OFF and the selector lever in OFF. Fig. C-11.
6. Close the fuel pump breaker on the engine control panel. Fig. C-12. The fuel pressure should be 20 to 25 psi. The BLUE alternator failure light will come on when the breaker is switched on but no alarm bells will ring.
7. Turn the engine control switch knob to IDLE and press the start button on the panel. Hold in firmly until engine fires evenly, then release.

LOCOMOTIVE OPERATION

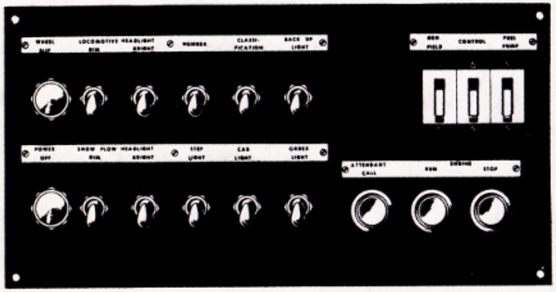
1. The engine must be running.
2. Place the engine control switch on each unit in RUN.
3. The alarm bells must not be ringing.
4. Check the following:
   a) Control air gauge on high voltage cabinet wall. Should be 90 psi.
   b) Battery ammeter charging.
   c) Main reservoir pressure between 115 and 125 psi.
   d) Action of air brakes, bell, horn and sanders.
5. **On a Leading A Unit** - Fig. C-9.
   a) Close all the breakers on the breaker panel in the front of the high voltage cabinet.
   b) Close the control and fuel pump breakers on the engineer's control panel. Fig. C-10.
   c) Move reverser to desired position and selector lever to position 1.
   d) Brake valve cut-out cock should be OPEN.
   e) Rotair valve must be in PASS or FRGT depending on type of service.
   f) Independent brake should be ON.
6. **On a Trailing A Unit**
   a) The throttle must be in IDLE, the selector lever in OFF and the reverser lever should be removed.

b) The brake valve cut-out cock should be CLOSED and automatic brake handle removed.
c) The rotair valve should be in PASS LAP or FRGT LAP depending on service.
d) Open the control, fuel pump and generator field breakers on the engineer's control panel.
e) Close all the breakers on the breaker panel in the front of the high voltage cabinet.

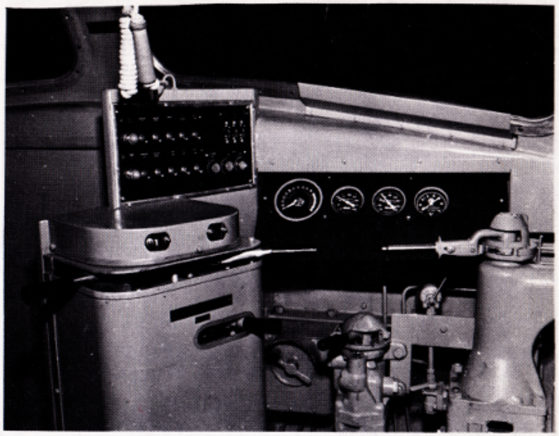
7. **On a Trailing B Unit** - Fig. C-7.
   a) The throttle lever should be in OFF and the reverser lever removed. (Note that the throttle lever OFF position is sometimes referred to as IDLE as the engine will continue to run.).
   b) The brake pipe cut-out cock should be closed. The brake handle should be removed.
   c) The controlled emergency cock on the D-24 control valve should be in the F or P position to correspond to the rotair valve in the leading A unit. Fig. C-8.
   d) Open the control, fuel pump and generator field breakers on the hostler breaker panel.
   e) Check that the NS-1 reducing valve cut-out cock on the brake stand is closed.
   f) Close all the breakers on the breaker panel in the front of the high voltage cabinet.

To Start the Locomotive

1. Check that all the hand brakes are RELEASED.
2. Close the generator field switch on the engineer's control panel of the leading unit.
3. Place foot on safety control pedal and RELEASE air brakes.
4. Open throttle, considering:
   a) Train weight
   b) Slack action, depending upon the length of the train
   c) Rail conditions, throttle may be opened as fast as train and rail conditions permit, but speed not to exceed 83 mph.



ENGINEER'S CONTROL PANEL
Fig. C-10

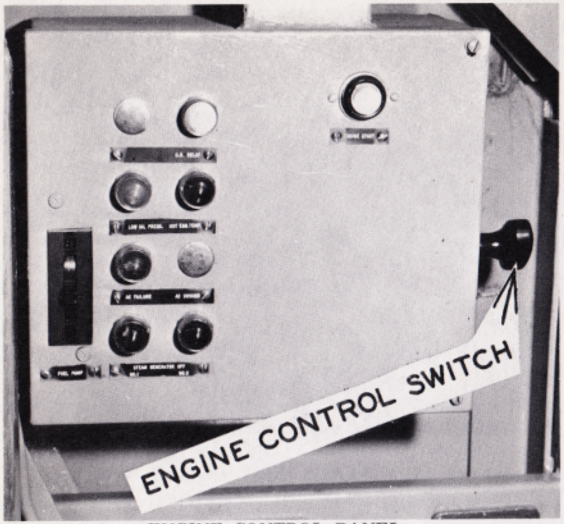


ENGINEER'S CONTROL STAND
Fig. C-11

5. Maximum load meter amperage in the ORANGE zone is permissible on starting and acceleration, provided the pointer steadily returns to the GREEN zone.

How to Stop and Shut Down the Locomotive

1. Apply brakes and make sure the throttle is in IDLE before train comes to halt.
2. Apply independent brake and RELEASE the automatic brake.
3. Open the generator field breaker.
4. Move the selector and reverser levers to OFF.
5. Remove the automatic brake and reverser levers.
6. At the engine control panel of each unit, turn the engine control switch to STOP which will stop the engine. Open the fuel pump breaker.
7. In emergency, all engines on the units can be shut down by pressing the stop button of the stop-run switch on the engineer's control panel in the leading unit. The alarm bells will ring and the A.C. failure lights come on if the EC switch is in RUN. To stop these alarms, turn EC switch to IDLE.
8. At the engineer's control panel in the lead unit, open the control and fuel pump breakers. The breakers on the breaker panel in each high voltage cabinet may be left closed. To prevent possible prolonged battery current draw, open the battery breaker.
9. Apply the hand brakes on each unit.



ENGINE CONTROL PANEL
Fig. C-12

B UNIT OPERATION

See Road Freight B Unit Operation

Ammeter Current-Time Limits

The load ammeter MOTORING scale runs from 0 to 1500 amperes, each division indicating 100 amps. The scale is GREEN up to 1085 amps. and ORANGE from there on. It should be noted that the segment at 1000 amperes is also ORANGE. Tonnages must be limited to those that will allow the load ammeter to remain within the specified load limits.

Load current is normally taken care of by the automatic transition equipment, however, at 14 mph and below the pointer should not be allowed to remain in the following overload positions for longer than the times indicated:

Amperes	Time Limit
1085	No limit
1100	50 minutes
1200	12 minutes
1300	6 minutes
1400	4 minutes

Note: Do not go over 1000 amperes mark (indicated by the ORANGE mark on the scale) for twenty minutes after using any one of the short time ratings.

Operation with the Leading Unit Shut Down

1. Open the control and fuel pump breakers on the engineer's control panel in the cab of the lead unit.
2. Close these two breakers at the hostler control station in one of the trailing B units, or at the engineer's control panel in the cab of the trailing A unit. The battery of the lead unit now supplies power for its lights, fuel pump, motor alternator set and cab heaters, but no longer supplies control power for all the units.

Traction Motor Cut-Out Switch – Fig. C-9.

This switch has the following positions:

Position	Function
CO1	No. 1 traction motor is cut out. Load ammeter will not function.
CO2	No. 2 traction motor is cut out.
CO1 and CO2	The front truck is cut out.
CO3	No. 3 traction motor is cut out.
CO4	No. 4 traction motor is cut out.
CO3 and CO4	The rear truck is cut out.
All in	All the traction motors are cut in.

This switch is useful for isolating a badly flashed motor, or a motor whose blower motor has failed. ISOLATE the unit before turning the switch.

Sanders

The sander valve is located on the cab wall to the right of the automatic brake valve. This handle may be released immediately after depressing since sanding continues automatically for about 15 seconds after releasing the lever.

When testing the sanders, the reverser handle must be placed in the FOR position to obtain FORWARD sanding, and in the REV position for the reverser sanders to operate.

The sanders operate automatically during wheelslips and cease 15 seconds after the slipping stops.

Engine Control Switch Positions

The engine control switch is located just forward of the #2 end right hand carbody door, on the engine control panel. The switch has the following four positions: Fig. C-12.

STOP Used to shut the engine down.

IDLE The engine will run but unit cannot be loaded or moved under its own power. Switch must be in this position to start engine.

6 This position limits the loading of the unit to SIXTH throttle notch and is used as an intermediate step when putting a unit back on the line when it is not desirable to throttle down to accomplish this. When using this position allow the unit to come up to sixth notch engine speed and level off before moving switch to RUN. This position may also be used if necessary to reduce loading due to trouble on the unit.

RUN Full loading position.